

Method for Creating a Fibrous Substance Suspension used for Producing a  
Tissue Web or Hygiene Web

The invention relates to a method for creating a fibrous suspension used for producing a tissue web or a hygiene web. It further relates to tissue products made from a fibrous suspension produced according to such a method.

The production of tissue requires large amounts of water, determined by the extremely low consistency or stock consistency of the fibrous suspension to be fed to the relevant paper or tissue machine. In addition, tissue is produced with a very low basis weight between 8 and 40 g/m<sup>2</sup>, depending on the respective final product, such as, e.g., cellulose wadding (8 to 30 g/m<sup>2</sup>), hygiene tissue (14 to 25 g/m<sup>2</sup>), hygiene paper (8 to 30 g/m<sup>2</sup>), napkin paper (20 to 30 g/m<sup>2</sup>) and towel paper (20 to 40 g/m<sup>2</sup>).

Furthermore, these products have a low beating degree, which is necessary to ensure an adequate dewatering and drying of the web to be produced. However, as is generally known, the beating makes a major contribution to the mechanical properties of the final product. As a result, the low beating degree often conflicts with the requirements regarding mechanical properties.

In most cases, tissue products are produced from a bleached sulfite or sulfate fibrous suspension, sometimes mixed with bleached wood pulp and/or recovered fibrous paper stock (e.g., wet broke, broke, recovered paper, etc.) and/or some type of fibrous suspension in a single-cylinder or fourdrinier Yankee machine. This applies regardless of whether the respective tissue product contains filler that was produced through a beating process or another production process. The material used with the conventional process is currently either precipitate material or another material such as calcium carbonate, talc, TiO<sub>2</sub>, silica, etc.

In order to achieve the strongest possible bonding of the fillers to the fiber surface with a respective replacement of fibrous material by filler material, the corresponding treatment has recently been conducted through a so-called "Fiber Loading™" process, as is described, i.a., in US-A-5 223 090. In such a "Fiber Loading™" process, at least one additive, such as, e.g., a filler, is deposited on the wetted fiber surfaces of the fibrous material. The fibers can thereby be loaded, e.g., with calcium carbonate. To this end, calcium oxide and/or calcium hydroxide is added to the moist, disintegrated fiber material in such a way that at least a part thereof combines with the water present in the fiber material. The fiber material thus treated is subsequently treated with carbon dioxide.

With methods of the type mentioned at the outset and known from US 6 413 365 B1 and DE 101 07 448 A, a disperger is respectively used which can also be used at the same time as a reactor for the chemical precipitation reaction.

The object of the invention is to disclose an improved method of the type mentioned at the outset with which the efficiency and cost-effectiveness of the production of corresponding tissue or hygiene products is further optimized.

This object is attained according to the invention through a method for producing a fibrous suspension used for the production of a tissue web or a hygiene web, in which method the fibers contained in the fibrous suspension are directly loaded with a filler in an online process in the tissue material preparation line through a chemical precipitation reaction.

The conventional fillers are thus replaced by a filler produced through a chemical precipitation reaction according to the "Fiber Loading™" process. The fibrous suspension treated accordingly has a higher drainability and a lower beating degree. Moreover, the fibers loaded with filler accordingly have a lower water retention value. The respective tissue product can be produced more cost-effectively because the water of the fibrous suspension can be removed much

more quickly and the tissue web can be dried more quickly. With loading the fibers according to the "Fiber Loading™" process, higher values result in terms of drainability with the same beating degree, so that a higher beating degree can be achieved, which means better mechanical properties for the final product. The lower water retention or better drainability and better drying prove to be an advantage in particular when the respective final product is subsequently printed.

With the corresponding treatment through a "Fiber Loading™" process, crystalline precipitation product particles in particular can be produced in the online process.

The precipitation product is preferably calcium carbonate. In this case, according to a preferred practical embodiment of the method according to the invention, it is provided that to load the fibers of the fibrous suspension, calcium oxide and/or calcium hydroxide is added and the precipitation is initiated through carbon dioxide or a gas containing carbon dioxide (for example, flue gas or the like). The crystalline precipitation product particles are thereby produced in the respective gas atmosphere preferably without the introduction of mixing energy.

With the loading of the fibers, calcium carbonate is thus deposited here on the wetted fiber surfaces by adding calcium oxide and/or calcium hydroxide to the moist fiber material, whereby at least part thereof can combine with the water of the fibrous material. The fiber material thus treated is then treated with carbon dioxide or a gas containing carbon dioxide. Moreover, the calcium carbonate ( $\text{CaCO}_3$ ) obtained can form a suspension around and between the fibers.

The term "wetted fiber surfaces" can apply to all the wetted surfaces of the individual fibers. This also covers in particular the case in which the fibers are loaded with calcium carbonate both on their outer surface and in their interior (lumen).

Accordingly the fibers are loaded with the filler calcium carbonate, the deposition on the wetted fiber surfaces being carried out by a so-called "Fiber Loading™" process, as described as such in U.S. Pat. No. 5,223,090. In this "Fiber Loading™" process, the carbon dioxide reacts with the calcium hydroxide to form water and calcium carbonate.

The fibrous suspension is preferably fed to a treatment unit comprising a fluffer, a refiner, a disperger and/or the like. The treatment unit can thereby have, e.g., a structure such as is described in US 6,413,365 B1 and DE 101 07 448 A.

The fibers of the fibrous suspension can be loaded with filler before or after the treatment unit comprising a fluffer, a refiner, a disperger and/or the like. However, in principle, embodiments of the method are also conceivable in which the treatment unit comprising a fluffer, a refiner, a disperger and/or the like is also used at the same time as a reactor for the chemical precipitation reaction. In this respect, the method can thus also be embodied, e.g., as described in the two above-mentioned printed publications.

The calcium hydroxide can be added to the fibrous suspension in liquid form or in dry form.

A preferred practical embodiment of the method according to the invention is characterized in that the fibrous suspension, e.g., the fibrous suspension mixed beforehand with calcium hydroxide, is fed to the treatment unit comprising a fluffer, a refiner, a disperger and/or the like with a stock consistency that lies in the range of approx. 5 to approx. 60% and preferably in a range of approx. 15 to approx. 35%.

The carbon dioxide or the gas containing carbon dioxide can be added before, after and/or into the treatment unit.

The carbon dioxide or the gas containing carbon dioxide is advantageously added at a temperature that lies in a range of approx.  $-15$  to approx.  $120^{\circ}\text{C}$  and preferably in a range of approx.  $20$  to approx.  $90^{\circ}\text{C}$ .

With the "Fiber Loading<sup>TM</sup>" process, individual precipitation product particles can be produced which are deposited on the fibers or deposited in the same at equal intervals. In the gas zone provided for carrying out the precipitation reaction, the separate, individual fibers can be exposed to the respective gas atmosphere, whereupon the corresponding precipitation reaction occurs and directly after that the calcium carbonate ( $\text{CaCO}_3$ ) is obtained.

For example, crystalline precipitation product particles with a rhombohedral form, a scalenohedral form and/or spherical crystalline product precipitation particles can be produced. The respective amount of crystalline precipitation product particles depends, i.a., on the respective temperature range for the fibrous suspension and the carbon dioxide and, e.g., on the proportion of calcium hydroxide in the fibrous suspension.

Advantageously, a treatment unit is used in the form of a disperger with two plates opposite to one another and rotating relative to one another and preferably in the form of a disperger with a rotor and a stator. The respective disperger, for example, can thereby again have a structure such as the disperger described in US 6,413,365 B1 and DE 101 07 448 A.

In a corresponding treatment unit the dimensions of the crystalline precipitation product particles are preferably influenced in the desired manner. For example, a corresponding distribution of crystalline precipitation product particles in the fibrous suspension can be ultimately achieved. Preferably only low shearing forces are generated thereby in the respective treatment unit.

In particular when passing through the treatment unit, for example, crystalline precipitation product particles can be produced, the maximum dimensions of which lie in a range of approx. 0.05 to approx. 5  $\mu\text{m}$  and preferably in a range of approx. 0.3 to approx. 2.5  $\mu\text{m}$ .

Depending on the respective type of paper, for example, crystalline precipitation product particles with a rhombohedral form with a respective edge length in a range of approx. 0.05 to approx. 2  $\mu\text{m}$ , or crystalline precipitation product particles with a scalenohedral form with a respective length in a range of approx. 0.05 to approx. 2  $\mu\text{m}$  and a respective diameter in a range of approx. 0.01 to approx. 0.5  $\mu\text{m}$  can be produced.

Advantageously, the fibrous suspension is diluted with water, preferably in a radially outer area of the treatment unit comprising two plates rotating relative to one another. The further radially outwards the fibrous suspension reaches on the rotor disk, the lower the respective shear or shearing force in view of the fed dilution water.

The stock consistency of the fibrous suspension guided through the treatment unit is advantageously in a range of approx. 0.1 to approx. 50% and preferably in a range of approx. 5 to approx. 35%.

Expediently, a constant feed of carbon dioxide or gas containing carbon dioxide is provided. To this end the carbon dioxide or the gas containing carbon dioxide is added, e.g., under a pressure that lies in a range of approx. 0.1 to approx. 6 bar and preferably in a range of approx. 0.5 to approx. 3 bar.

Thereby, for example, a corresponding pressure in the respective carbon dioxide supply line can be provided via which the gas, i.e., the carbon dioxide or the gas containing carbon dioxide, is fed, e.g., to form a gas ring that can also be produced, e.g., in the respective treatment unit. As with a garden hose, the

respective pressure is then thus increased accordingly with higher water quantity required. Since the carbon dioxide is a compressible gas, the respective supplied amount of gas can also be increased accordingly in order to ensure a complete precipitation reaction.

According to a preferred practical embodiment of the method according to the invention, in the course of the chemical precipitation reaction an at least essentially complete conversion of the referenced base materials calcium oxide or calcium hydroxide and carbon dioxide into the reaction products calcium carbonate and water is ensured by accordingly regulating or controlling the pH value of the fibrous suspension, preferably via the supply of carbon dioxide or gas containing carbon dioxide. In particular a pH value can thereby be established which lies in a range of approx. 6 to approx. 10 and preferably in a range of approx. 7 to approx. 8.5. Corresponding values can be provided in particular for the final reaction.

The energy introduced for such a chemical precipitation reaction preferably lies in a range of approx. 0.3 to approx. 8 kWh/t and preferably in a range of approx. 0.5 to approx. 4 kWh/t.

Advantageously, sufficient dilution water to be mixed with the fibrous suspension is added so that a stock consistency of the diluted fibrous suspension finally results which lies in a range of approx. 0.1 to approx. 16% and preferably in a range of approx. 2 to approx. 6%.

The fibrous suspension can then be exposed to atmospheric pressure and fed to a following machine or it can be placed in a container or box. The fibrous suspension can then thus be fed, e.g., to the next process equipment that follows in the process for producing a tissue or hygiene web.

The treatment unit is preferably operated such that its rotating plate or rotor has a circumferential speed at the radially outer edge in a range of approx. 20 to approx. 100 m/s and preferably in a range of approx. 40 to approx. 60 m/s.

The width of the gap between the two plates of the treatment unit rotating relative to one another is advantageously in a range of approx. 0.5 to approx. 100 mm and preferably in a range of approx. 25 to approx. 75 mm.

The diameter of the two plates rotating relative to one another of the treatment unit or of the rotor and the stator expediently lies respectively in a range of approx. 0.5 to approx. 2 m.

The reaction time for the chemical precipitation reaction can lie, e.g., in a range of approx. 0.01 min to approx. 1 min and preferably in a range of approx. 0.1 s to approx. 10 s.

If necessary, free calcium carbonate, i.e., not deposited in and/or on the fibers, can be washed out.

In principle, a pressure container is not necessary.

With the method according to the invention, thus at least part of the variables cited below have an effect: fibrous suspension, calcium oxide and/or calcium hydroxide in liquid or dry form, carbon dioxide, gas zone, rotor, stator, crystals produced in a gas atmosphere without introducing mixing energy, mixing at low shearing force, no pressure container.

With the method according to the invention, individual crystalline precipitation product particles can be produced which are deposited on or in the fibers at equal intervals in the manner necessary in order to meet the requirements for the



respective tissue product. The particle sizes given above, for example, can thereby be produced.

After the "Fiber Loading™" process has been completed, the following advantages result, i.a., regarding the stock properties for the tissue product:

The fibrous suspension treated according to the "Fiber Loading™" process has a higher drainability or a lower beating degree. The respective values can lie, e.g., in a range of 5 to approx. 100 ml CSF or in a range of approx. 0.2 to approx. 15°SR, depending on the drainability or the beating degree. Furthermore, the fibers loaded accordingly have lower water retention values, which can lie, e.g., in a range from approx. 2 to approx. 25%, depending on the respective furnish. Tissue paper can now be produced in a more cost-effective manner, since water can be removed much more quickly from the fibrous suspension and the tissue web can be dried more quickly.

For tissue applications for which no specific filler content is necessary, the free precipitated calcium carbonate, i.e., the calcium carbonate not deposited in or on the fibers, can be removed by a washing process before the fibrous suspension is fed to the respective tissue machine or, if necessary, before the beating process. As a result, the fibers still remain covered with calcium carbonate, which provides the advantage that the dewatering is facilitated and the drying accelerated and, moreover, a lower re-moistening of the final tissue product results.

The "Fiber Loading™" process can be applied in principle before beating, after beating or during beating, depending on the requirements of the respective final product.

Since a higher drainability results with an equal beating degree when the fibers are loaded with a precipitation product, a greater beating is possible, which leads to better mechanical properties of the final product.

Lower water retention and better drying are an advantage in particular if the respective product is subsequently printed.

Two embodiments of the invention are shown purely by way of example in a simplified diagrammatic representation in Figs. 1 and 2.

Fig. 1 thereby shows an exemplary embodiment in which the fibrous suspension 10 is first fed to the "Fiber Loading™" process 12 and subsequently is treated accordingly in a treatment unit 14 comprising, e.g., a refiner or the like. Subsequently, free calcium carbonate can be washed out in a washing step 16, if necessary. As the above shows, however, such a washing step 16 can also be omitted. Subsequently, the fibrous suspension 10 treated accordingly is fed to a tissue machine 18, whereby the desired tissue or hygiene web 20 and thus the respective final tissue product is finally obtained.

The exemplary embodiment shown in Fig. 2 differs from that in Fig. 1 only in that the fibrous suspension 10 first is fed to the treatment unit 14 comprising, e.g., a refiner or the like and only afterwards to the "Fiber Loading™" process. The washing step 16 is by no means obligatory in this case either.

In both cases the fibers contained in the fibrous suspension 10 are directly loaded in an online process with a filler in the tissue material preparation line by a chemical precipitation reaction, crystalline precipitation product particles being produced in the online process. The precipitation product is preferably calcium carbonate. In this case, calcium oxide and/or calcium hydroxide is added to the fibrous suspension to load the fibers. The precipitation is then initiated through carbon dioxide or a gas containing carbon dioxide (e.g., flue gas or the like). The

crystalline precipitation product particles are thereby produced in the respective gas atmosphere without the insertion of mixing energy. The fibrous suspension can be fed in particular to a treatment unit 14 comprising a fluffer, a refiner, a disperger and/or the like. The fibers of the fibrous suspension 10 can thereby be loaded with filler before or after the treatment unit 14. In principle it is also conceivable to use the treatment unit 14 at the same time as a reactor for the chemical precipitation reaction.

List of Reference Numbers

10	Fibrous suspension
12	"Fiber Loading™" process
14	Treatment unit
16	Washing step
18	Tissue machine
20	Tissue or hygiene web